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Wear resistant multilayer nanocomposite WC1-x/C coating on Ti-6Al-4V titanium alloy

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1. Introduction

Titanium alloys are attractive constructional materials thanks to its properties: low density, high strength and high electrochemical corrosion resistance. On the other hand, poor tribological properties like high coefficient of friction and tendency to seizure during dry sliding against numerous materials result in many limitations in use of titanium alloys. Attempts to overcome these disadvantages by surface and near-surface zone hardening with use of interstitial C, N, or O atoms do not improve its tribological properties [1]. However, additional coating deposition can be a promising alternative to improve the tribological properties and wear resistance. Improvement gain by coating deposition has been investigated on different materials. Ramalho et al. [2] and Zaidi et al. [3] reported the results of tribological investigations of coatings on steel. In case of titanium Ti-6Al-4V alloy, low elastic modulus makes it difficult to achieve good tribological properties after hard coating deposition.

In this paper, a significant improvement of tribological properties on Ti-6Al-4V has been presented, achieved by a novel, original multiplex hybrid treatment of titanium alloys.

2. Coating deposition and tribological analysis

Proposed treatment consists of an intermediate 2 μm thick TiC_xN_y layer which has been deposited by reactive arc evaporation onto diffusion hardened material with interstitial O or N atoms by glow discharge plasma in the atmosphere of $Ar+O_2$ or $Ar+N_2$. Subsequently, an external 0.3 μm thick nanocomposite carbon-based WC_{1-x}/C layer has been deposited by reactive magnetron sputtering of graphite and tungsten targets. The morphology, microstructure, chemical and phase composition of the substrate material after multiplex treatment have been investigated with use of AFM, SEM, EDS, EDX, XRD, 3D profilometry with quantitative optical interferometer topography analysis, followed by tribological investigation of non-lubricated small displacement wear and friction analysis.

3. Summary

An increase of hardness of the diffusion treated near-surface zone of the Ti-6Al-4V alloy has been achieved. In addition, a good adhesion between the intermediate gradient TiC_xN_y coating and the Ti-6Al-4V substrate as well as with the external nanocomposite coating has been obtained. Significant increase of wear resistance (94%) in comparison to uncoated Ti-6Al-4V is reported. Small decrease (10%) of averaged coefficient of friction (μ_a) has been observed.

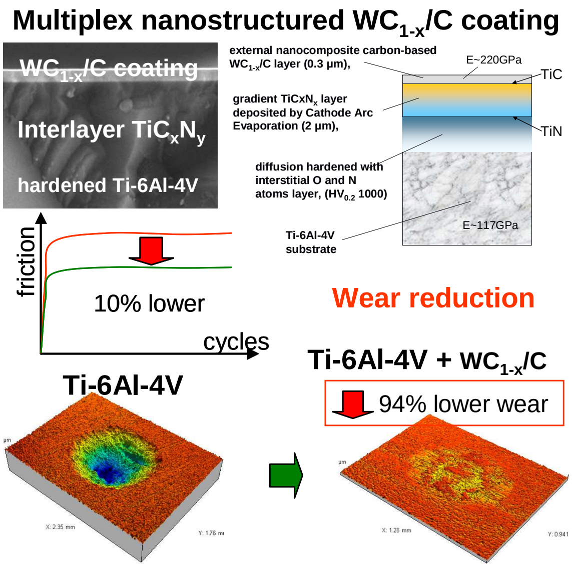

Fig. 1: Wear and friction reduction by multiplex treatment process with nanostructured WC_{1-x}/C coating.

The proposed multiplex treatment of the Ti-6Al-4V alloy is a promising alternative to significantly increase the wear resistance of the titanium alloys.

4. References

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